



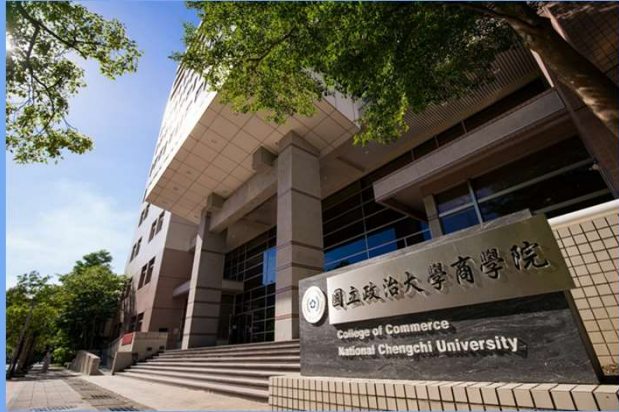
國立政治大學資訊管理學系

NCCU DEPARTMENT OF MANAGEMENT INFORMATION SYSTEMS

# Introduction to Computer Science

## Week 5- Network

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## Network

Network is a system of multi-devices linked by wires, cables, or a telecommunications system

- Combine hardware and software
- Enable a networks to communicate
- Allow computers to share resources
  - Hardware, software, data, and information
- Distributed computing to enhance system performance

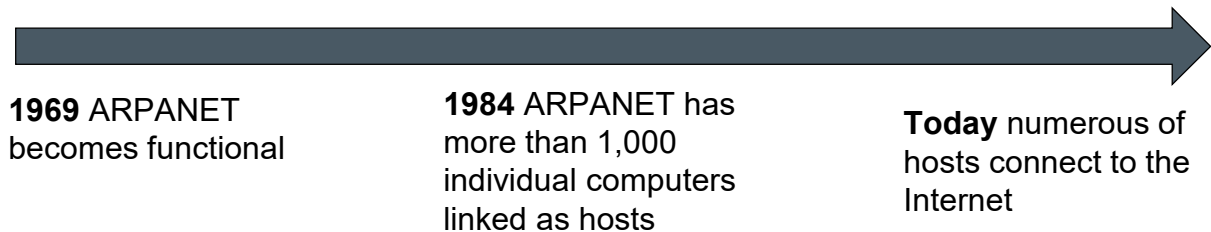


## ARPANET (Advanced Research Projects Agency Network)

The Internet originated as ARPANET in September 1969

Two main goals :

1. Allow scientists at different **physical locations** to share information and work together
2. Function even if **part** of the **network** were **disabled or destroyed** by a disaster

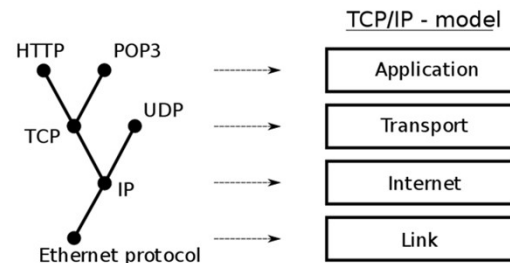


## Communication Protocol

Rules that are required to exchange messages between computing systems

- TCP/IP
- HTTP: hypertext transfer protocol
- FTP: file transfer protocol
- UDP, POP3, SMTP, ...

**Layering** is a design principle that divides the protocol design into smaller steps, each of which accomplishes a specific part



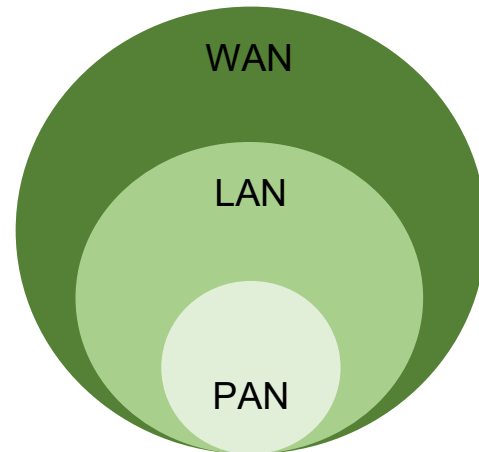
Source: [https://www.wikiwand.com/en/Communication\\_protocol#/Layering](https://www.wikiwand.com/en/Communication_protocol#/Layering)



## What is a Network

Computer network to **connect to each other**

- Wide area network (WAN)
- Local area network (LAN)
- Personal area network (PAN)



## Personal Area Network (PAN)

**PAN** is a network for interconnecting devices centered on an **individual's** workspace

- A network that connects computers and devices in an **individual's workspace** through wired and wireless technologies
- Devices on PAN are usually connected via Bluetooth
  - Bluetooth: a short-range wireless technology
  - Physical range: typically less than 10 m



## Local Area Network (LAN)

LAN is a network that connects computers and devices in a **limited geographical area**

- Home, school, office building, departments, etc.

Each computer or device on the network, called a **node**, which often shares resources

- Printers, hard drives, etc.

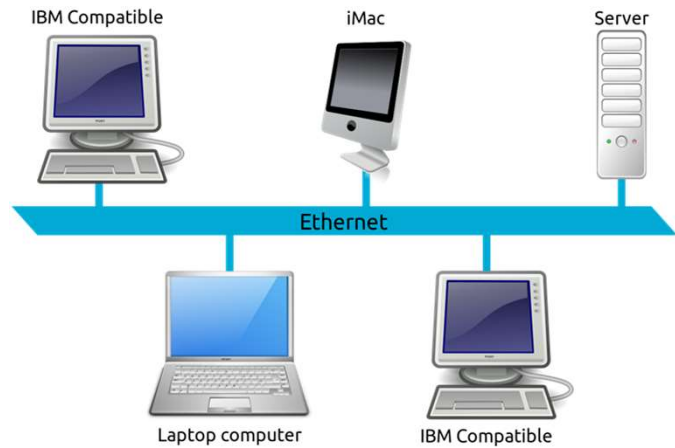


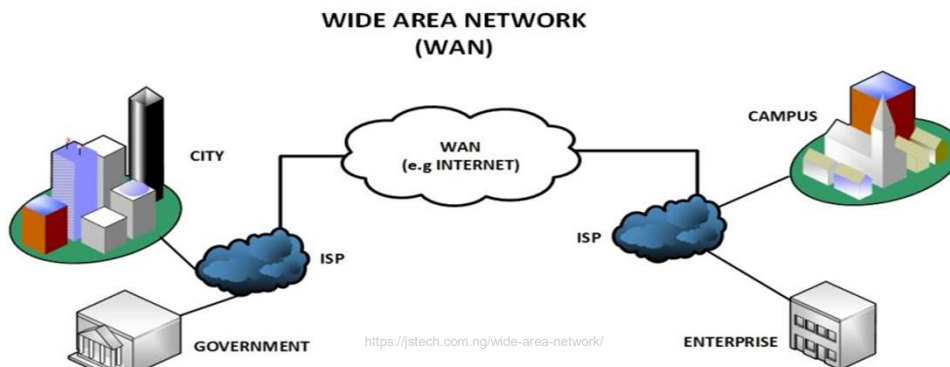
Image credit: [https://en.wikipedia.org/wiki/Local\\_area\\_network#/media/File:Ethernet\\_LAN.svg](https://en.wikipedia.org/wiki/Local_area_network#/media/File:Ethernet_LAN.svg)



## Wide Area Network (WAN)

**Wide Area Network (WAN)** is a telecommunication network that extends over a large geographic area for the primary purpose of computer networking

- The Internet may be considered a WAN



<https://jstech.com.ng/wide-area-network/>



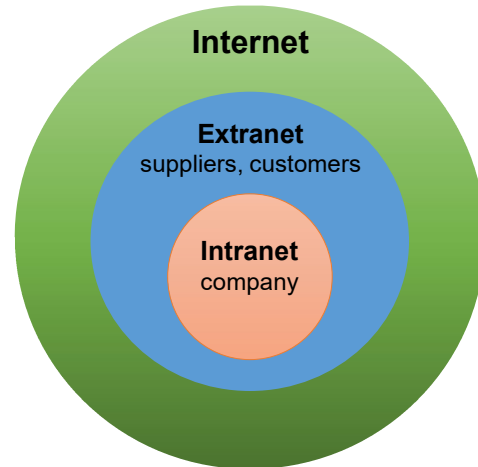
## Computer Network for Sharing Information

### Intranet

- A private network for authorized individuals
- Companies use the intranet to communicate internally

### Extranet

- Allows outsiders (such as customers and suppliers) to access an organization's intranet
- A supplier can check the customer's inventory level before deciding whether to ship other products



	Internet	Extranet	Intranet
Type of Network	Public	Private	Private
Accessibility	Anyone	<u>Authorized</u> people	<u>Authorized</u> people
Size	<u>Large</u> number of connected to the devices	Limited number of connected devices <b>over internet</b>	Limited number of connected devices
Information Sharing	Information can be shared across the world	Information can be shared b/t employees and external people	Information can be shared securely <b>within an organization</b>
Example	World Wide Web, Social media, Email	Network of collaboration b/t corporations	Internal operations within an company



## Network Architecture- Client/Server

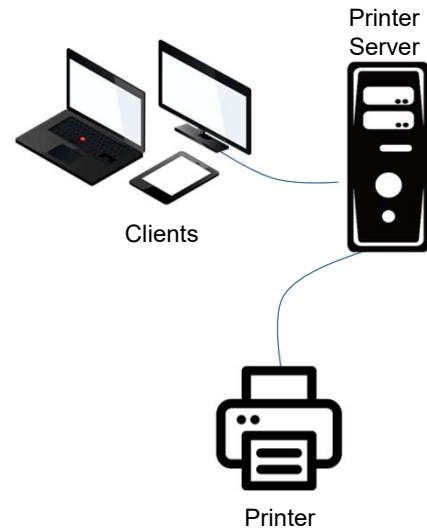
Server: provide service(s)

- Centralized storage location which is accessible to other computers on the network

Client: other computers on the network request resource from the server(s)

- Rely on the server for its resources
- Different clients may have different permissions to access files or resources

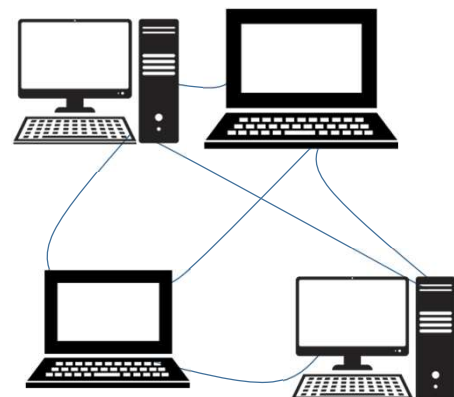
Can connect to one or more servers to sharing files or resources



## Network Architecture- P2P

Peer-to-peer (P2P) network

- Computers **communicate directly with each other** and share each other's resources
  - Computer-A uses a printer connected to Computer-B and revising a file stored on Computer-C
- Administrator is not required since the P2P network treats all computer equally





## Network Architecture- Cloud Computing

Cloud computing is an Internet-based service

- Data storage, data computing, etc.
- Data may store on one or more servers in different locations (backup copies)

### Pros

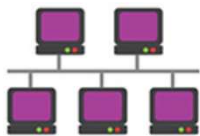
- Easy to share files and control who has access to each file
- If there is any problem with your computer, the file will remain unchanged

### Cons

- Cost of managing the accessibility
- Internet connectivity



## Network Topology



### Bus topology

All devices attach to a central cable (called bus) to transfer data  
If the **bus** fails, the devices on the network will not be able to communicate



### Ring topology

Data is transferred sequentially from one device to another  
If **one of the devices** on the network fails, the communication is no longer available



## Network Topology



### Star topology

- Every device on the network is connected to the central device (server/switch/hub)
- If the central device fails, other devices will not be able to communicate
- The bus can also be used to connect multiple star networks together to form a tree topology
- Tree topology is usually used in schools and enterprises



### Mesh topology

- All devices interconnect with each other
- If a single device on the network fails, the rest of the network will communicate through the alternate route to continue operation
- Full mesh topology: each device on the network is connected to all other devices on the network

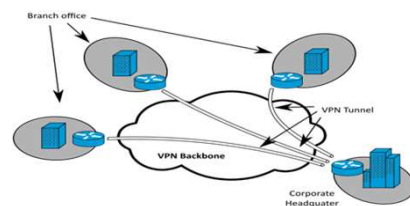
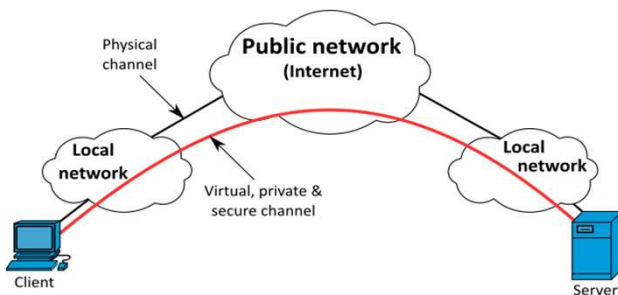


## Virtual private network (VPN)

VPN **extends a private network to a public network** and allows users to send and receive data through networks

VPN provides a **secure path across public networks**, allowing authorized users to access the organization's network

By using encryption technologies, VPN can protect the data transmitted along the path



[https://www.youtube.com/watch?v=\\_wQTRMBAvg](https://www.youtube.com/watch?v=_wQTRMBAvg)



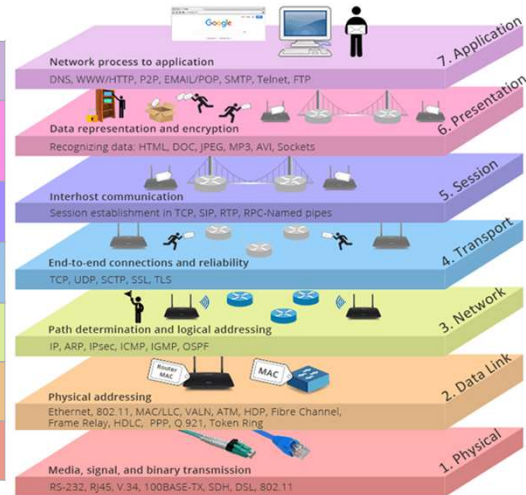


## OSI (Open System Interconnection) Model

Conceptual model that characterizes and standardizes the communication functions of a telecommunication or computing system

7	Application	High-level APIs, including resource sharing, remote file access
6	Presentation	Translation of data between a networking service and an application; including character encoding, data compression and encryption/decryption
5	Session	Managing communication sessions, i.e. continuous exchange of information in the form of multiple back-and-forth transmissions between two nodes
4	Transport	Reliable transmission of data segments between points on a network, including segmentation, acknowledgement and multiplexing
3	Network	Structuring and managing a multi-node network, including addressing, routing and traffic control
2	Data link	Reliable transmission of data frames between two nodes connected by a physical layer
1	Physical	Transmission and reception of raw bit streams over a physical medium

Photo: [https://en.wikipedia.org/wiki/OSI\\_model](https://en.wikipedia.org/wiki/OSI_model)  
<https://community.fs.com/blog/tcpip-vs-osi-whats-the-difference-between-the-two-models.html>



w5 1:19:54



## IP address and Domain Name System

An IP address is a sequence of numbers that uniquely **identifies each computer** or device's location to connected to the Internet or any other network

The **domain name** is a text-based name which **corresponds to the IP address** of the server

The **Domain Name System (DNS)** server **converts** the domain name to its associated IP address

IPv4 address: 74.125.22.139  
 IPv6 address:  
 2001:4860:4860::8844  
 Domain name: google.com

	IPv4	IPv6
Full Name	Internet Protocol version 4	Internet Protocol version 6
Format	32-bit Internet addresses	128-bit Internet addresses
Capacity	2 <sup>32</sup> IP addresses (4.29 billion)	2 <sup>128</sup> IP addresses



## Top Level Domain (TLD)

TLD	Intended Purpose
.com	Commercial organizations, businesses, companies
.edu	Educational institutions
.gov	Government agencies
.org	Nonprofit organizations
.biz	Commercial organizations, businesses, companies



## Uniform Resource Locator (URL)

Webpage has a unique address, called a **web address** or Uniform Resource Locator (URL)

protocol   host name   domain name   path name   webpage name

[https://www.lib.nccu.edu.tw/zh\\_tw/service/201](https://www.lib.nccu.edu.tw/zh_tw/service/201)

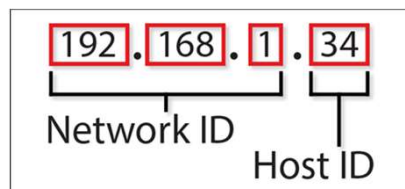


## TANet (Taiwan Academic Network)

Most of TANet IP begins with 140.92, 140.109 to 140.138

Domain name mainly end with edu.tw

- Network ID identifies the specific network on which the device is located
  - On a typical home network, where a device has the IP address 192.168.1.34, the 192.168.1 part of the address will be the network ID
- Host ID identifies a specific device on that network
  - In the TCP/IP world, we call devices "hosts"



### University College IP Range [\[edit\]](#)

IP begins with 140

- National Taiwan University-----140.112
- National Chiao Tung University-----140.113
- National Tsing Hua University-----140.114
- National Central University-----140.115
- National Cheng Kung University-----140.116
- National Sun Yat-sen University-----140.117
- National Taiwan University of Science and Technology-----140.118
- National Chengchi University-----140.119



## How does internet work?

1. Input google.com in the browser's address bar
2. Browser asks DNS server: how to reach google.com (DNS server is maintained by service providers)
3. DNS looks up domain name and its associated IP address
4. DNS replies: go to 172.217.27.142
5. Browser uses the IP address and contact the Google web server to request the content
6. Google server checks with its DB regarding the requested content
7. DB finds the relevant information and responds to Google server
8. Google server sends the requested content to the user's browser (webpages)
9. Browser shows whatever it receives from the Google server on the screen

```
C:\Users\admin>nslookup google.com
伺服器: sun2cc.nccu.edu.tw
Address: 140.119.1.110

未經授權的回應:
名稱: google.com
Addresses: 2404:6800:4008:803::200e
172.217.27.142
```



[https://www.youtube.com/watch?v=7\\_LPdtIKXPc](https://www.youtube.com/watch?v=7_LPdtIKXPc)



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# Introduction to Computer Science

## Week 6- Network II

Shih-Yi (James) Chien

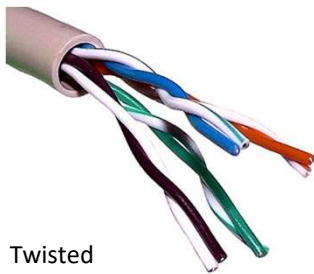
Assistant Professor

Dept. of Management Information Systems

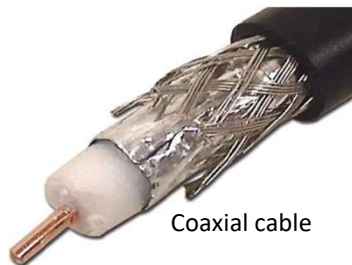
Email: [sychien@nccu.edu.tw](mailto:sychien@nccu.edu.tw)



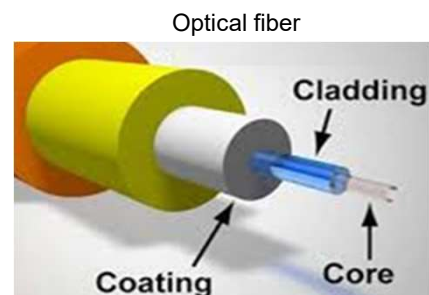
## Directed Media



Twisted  
Pair



Coaxial cable

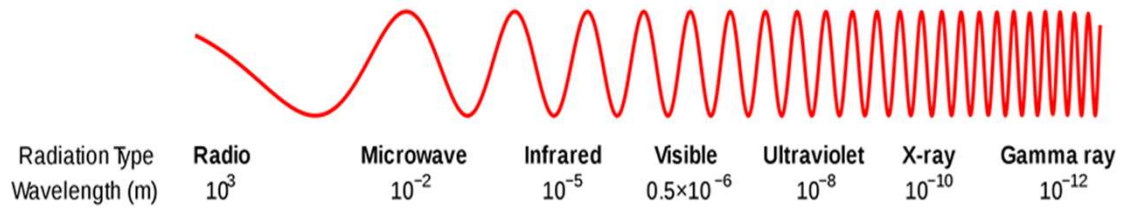


Optical fiber

Image credit: <https://www.youtube.com/watch?v=6NwmWP6EQxQ>  
Image credit: <https://images.app.goo.gl/rvMfpx3gQVcMjfd96>



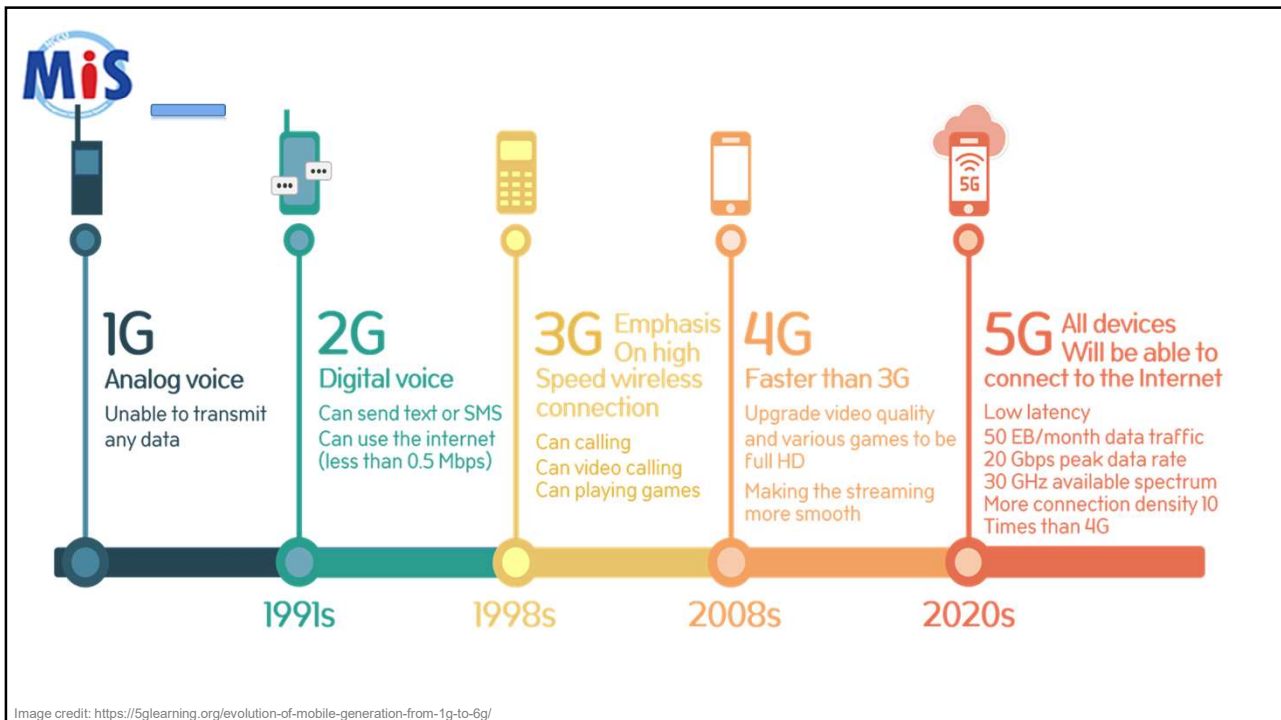
## Undirected Media: Electromagnetic Radiation



## Wi-Fi: 2.4 GHz vs. 5 GHz



Image credit: <https://www.hns-berks.co.uk/blogs/archives/04-2018/2>  
<https://beambox.com/townsquare/what-s-the-difference-between-2-4ghz-and-5ghz-wifi>



## Internet Service Provider (ISP)

Connects the network to the Internet through an ISP

- ISP is a business that provides Internet access to individuals and organizations for free or for a fee
- ISP may also provide online services, such as e-mail, personal Web site or home page

**Latency:** the time it takes a signal to travel from one location to another on a network

**Bandwidth:** the amount of data and information that can be transmitted through the transmission medium

- The measure of the network's capability to send and receive data





## Physical layer - Communications Lines

Dedicated line is a type of always-on physical connection that is established between two communication devices

- Cable
- DSL
- T-Carrier
- Optical fiber

Cable	256 Kbps to 100 Mbps or higher
DSL	256 Kbps to 8.45 Mbps
T1	1.544 Mbps
T3	44.736 Mbps



## Cable vs. DSL

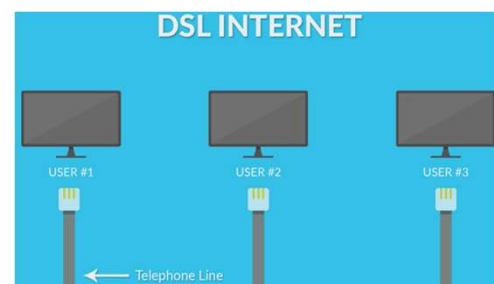
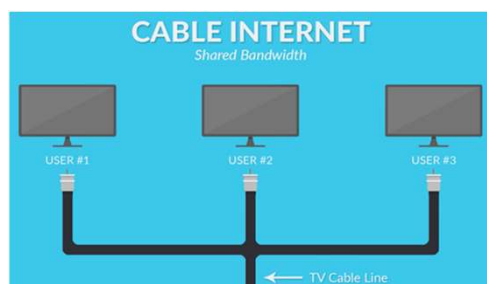


Image credit: <https://www.youtube.com/watch?v=6NwmWP6EQxQ>



## Elements and Devices to Create a Network

**Modem:** the communications device that connects a communications channel to a device

**Hub:** a central point in a network; transmit data to all devices

**Switch:** a central point in a network; only transmits data to the intended device(s)

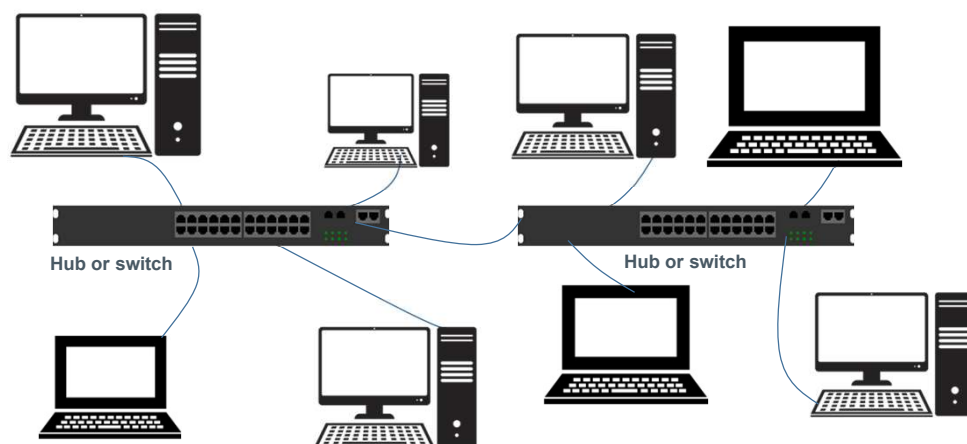
**Router:** device that connects two or more **networks**

- Connect the computer to the Internet
- Wireless router: provide wireless network access to the devices



## Hub vs. Switch

A hub or switch is a device which provides a central point for cables in a network





## MIS Router

A router connects multiple computers/devices or other routers together and transmits data to the destination on a network

- Through a router, the networks can share access to a broadband Internet connection, such as through a cable or DSL modem

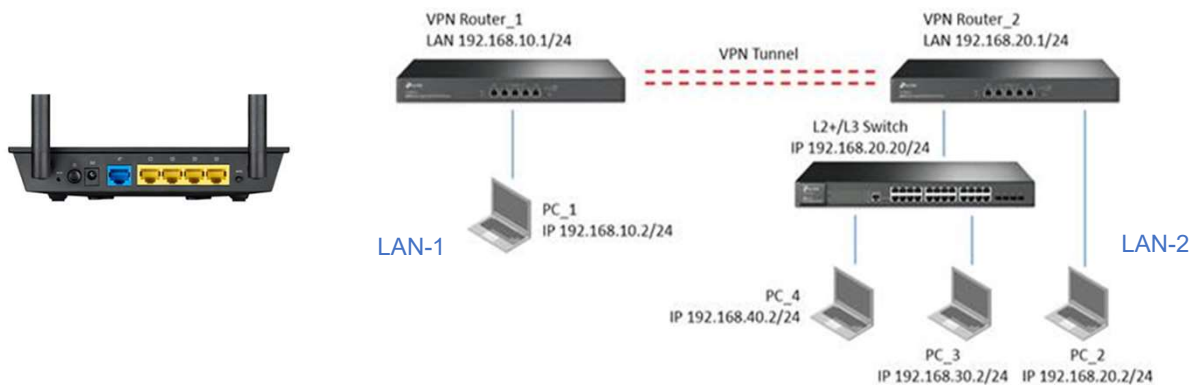
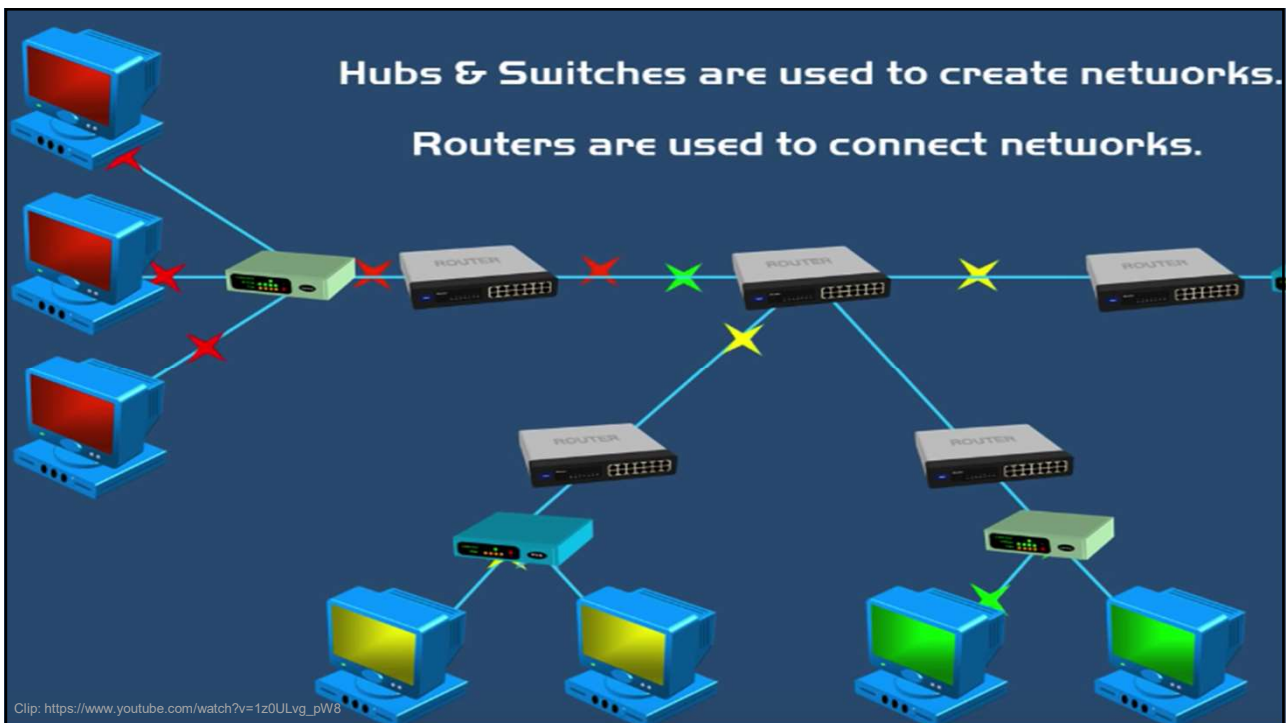


Image credit: <https://www.tp-link.com/tw/support/faq/2136/>



Clip: [https://www.youtube.com/watch?v=1z0ULvg\\_pW8](https://www.youtube.com/watch?v=1z0ULvg_pW8)



## Wi-Fi Router & Range Extender

- Wi-Fi router mode
- 4G (SIM card) + Router
- Boosts wireless signal to previously unreachable areas
- expand wireless coverage



Image credit: <https://www.tp-link.com/uk/home-networking/3g-4g-router/archer-mr600/>



Image credit: <https://www.tp-link.com/us/home-networking/range-extender/tl-wa850re/>



## Network Interface Controller/Card (NIC)

NIC enables computers or devices that without built-in networking capability can access network

NIC may have a visible antenna to communicate with the **wireless** network

- Wireless network interface card (WNIC)



Image credit: [https://en.wikipedia.org/wiki/Network\\_interface\\_controller](https://en.wikipedia.org/wiki/Network_interface_controller)



Image credit: <https://networkustad.com/2019/11/17/wireless-network-interface-card-wnic/>



## Mac Address

Media Access Control (MAC) address identifies a unique network interface

MAC address is a 12-digit string

- Each digit can be any number (0~9) or a letter (b/t A and F)
  - **E1-A5-5E-24-34-EB**
- First six digits represent the **adapter's manufacturer**
- Last six digits represent the unique identification num for that **specific adapter**

The MAC address **contains no information about which network a device is connected to**

- Deny access to specific MAC addresses, can't do it with IP address



## Mac Address & IP Address

IP address: where the target (like your home address)

- Assigned by ISPs and can be re-assigned as devices connect and disconnect
- Multiple devices (with virtual IPs) share a public IP
  - Many people live in the same place (same mail address)
- The IP address gets the data to your router

MAC address: who the target is (like your personal ID)

- Tied to a physical adapter and are assigned by manufacturers
- Every device on a router has a unique MAC address
  - Multiple personal IDs in your home
- MAC address identifies which device is which



## Traceroute

Traceroute and tracert are computer network diagnostic commands for displaying possible routes (paths) and measuring transit delays of packets across an Internet Protocol (IP) network

```
C:\Users\admin>tracert google.com

在 上限 30 個躍點上
追蹤 google.com [172.217.27.142] 的路由:

 1  1 ms    <1 ms   <1 ms   192.168.1.1
 2  <1 ms   <1 ms   <1 ms   140.119.113.254
 3  1 ms    <1 ms   <1 ms   140.119.240.254
 4  1 ms    <1 ms   13 ms   140.119.240.230
 5  2 ms    1 ms    1 ms    140.119.243.5
 6  3 ms    3 ms    4 ms    192.192.61.90
 7  4 ms    4 ms    4 ms    192.192.61.185
 8  4 ms    3 ms    3 ms    192.192.61.198
 9  3 ms    2 ms    3 ms    72.14.196.229
10  4 ms    4 ms    4 ms    108.170.244.97
11  4 ms    5 ms    4 ms    209.85.142.13
12  4 ms    4 ms    4 ms    tsa03s02-in-f14.1e100.net [172.217.27.142]
```

Try `tracert google.com`  
Try `tracert google.com`

<https://en.wikipedia.org/wiki/Traceroute>



## Servers

A **server** is a computer dedicated to providing services to other computers or devices on a network

- Tower server
  - Desktop or laptop can be
- Rack server
  - Require more spaces for the machines
  - Better scalability (more memory slots)
    - Might strengthen the computing power
- Blade server
  - Save space but cooling can be an issue
  - Limited spaces for scalability
  - Support hot plugging

### Types of Server Machines

Tower Server



Rack Server



Blade Server

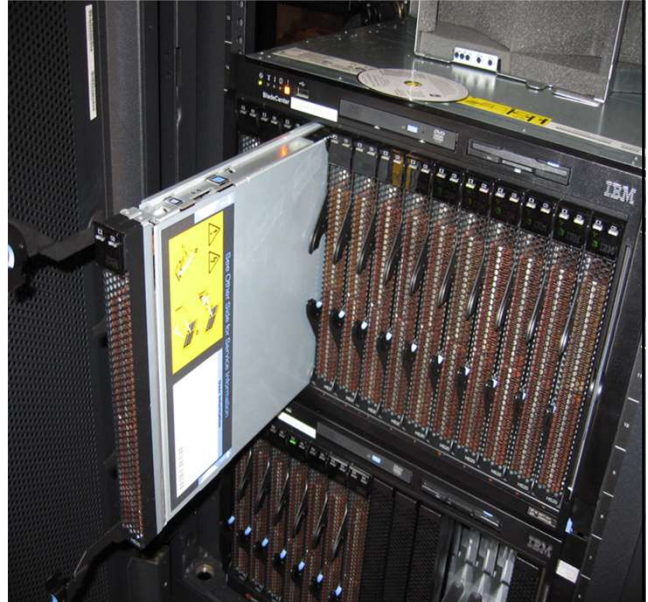


Photo credit: [https://www.youtube.com/watch?v=bhT1rV5IUQc&ab\\_channel=ITSimplifiedinHINDI](https://www.youtube.com/watch?v=bhT1rV5IUQc&ab_channel=ITSimplifiedinHINDI)





## Rack server vs. Blade server



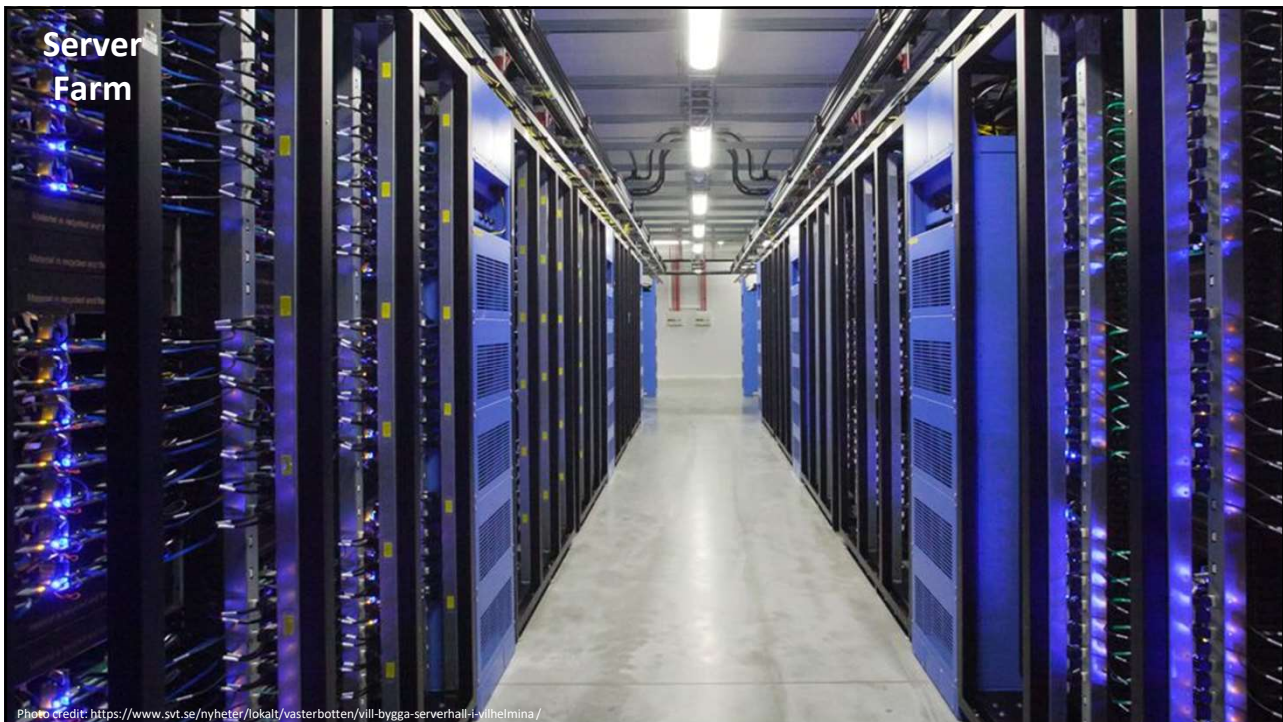


## Mainframe

Mainframes are large, expensive, powerful server that can handle **high-volume online transaction processing** simultaneously

- Highly reliable, robust backward compatibility
- Finance and banking industries
- High learning curve for most administrators





## Server Farm

A **server farm** is a network of multiple servers in a single location

- Increasingly being used instead of mainframes by large enterprises
- Server farms do **not yet reach the same reliability** levels as mainframes
- Num of computers in large server farms, the failure of an individual machine is common
- **Better scalability**, cost-effective, agile and innovative environments
- Easy to maintain the machines (with universal OS, such as Linux and Windows)



## **Dedicated Servers perform a specific service**

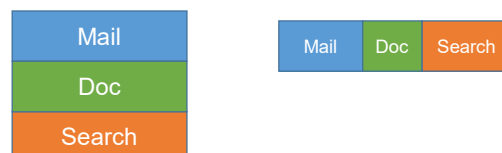
Type	Main Service Provided
Application server	Stores and runs apps
Backup server	Backs up and restores files, folders, and media
Database server	Stores and provides access to a database
Domain name server	Stores domain names and their corresponding IP addresses
File server	Stores and manages files
FTP server	Provides a central location for online gaming
Mail server	Stores and delivers email message
Print server	Manages printers and documents being printed
Web server	Stores and delivers requested webpages to a computer via a browser



## **Virtual Servers**

Virtualization is the practice of sharing or pooling computing resources, such as servers and storage devices

- Server virtualization uses software to enable a physical server to emulate the hardware and computing capabilities of one or more servers, known as [virtual servers](#)



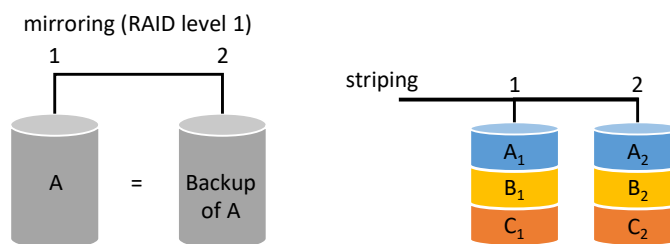
Clip: <https://www.youtube.com/watch?v=V9AiN7oJaIM>





## Enterprise Storage - RAID

- Enterprise hardware allows large organizations to manage and store data and information with equipment designed for heavy use, maximum efficiency, and maximum availability
- RAID** (redundant array of independent disks) is a group of two or more integrated hard drives
  - RAID duplicates data, instruction, and info to improve data reliability
  - RAID 0, 1, 5, and 10



Clip: <https://www.youtube.com/watch?v=U-OCdTeZLac>



## Backup

**Backup** is a copy of a file, program, or media. If the original file is lost, damaged or destroyed, you can use the backup

- To **back up** a file means to make a copy of it

Off-site backups are stored in a different location from the computer or mobile device site





## Types of Backups

**Differential backup:** the files changed **since last full backup**

(Sun $\leftarrow\rightarrow$ Mon, Sun $\leftarrow\rightarrow$ Tue)

**Incremental backup:** backup the files changed **since last incremental backup**

(Sun $\leftarrow\rightarrow$ Mon, Mon $\leftarrow\rightarrow$ Tue)

Type	Description
<b>Full backup</b>	A full backup is the process of making at least one additional copy of <b>all data files</b> that an organization wishes to protect in a single backup operation. The files that are duplicated during the full backup process are designated beforehand by a backup administrator or other data protection specialist.
<b>Differential backup</b>	A differential backup is a cumulative backup of <b>all changes made since the last full backup</b> , i.e., the differences since the last full backup. The advantage to this is the quicker recovery time, requiring only a full backup and the last differential backup to restore the entire data repository.
<b>Incremental backup</b>	An incremental backup is a backup type that only copies data that <b>has been changed or created since the previous backup activity</b> was conducted. An incremental backup approach is used when the amount of data that has to be protected is too voluminous to do a full backup of that data every day.
<b>Selective backup</b>	Selective backup is a type of data backup process in which only <b>user-specified data</b> , files and folders are backed up. It enables short listing only selected files in a backup process rather than backing up the whole folder, disk or system. Selective backup is also known as partial backup.



## DAS vs. NAS vs. SAN

DAS (direct attached storage)

- Simple, efficient, low cost

NAS (network attached storage)

- Remote access, file sharing, affordable, scalability
- small and medium enterprises

SAN (storage area network)

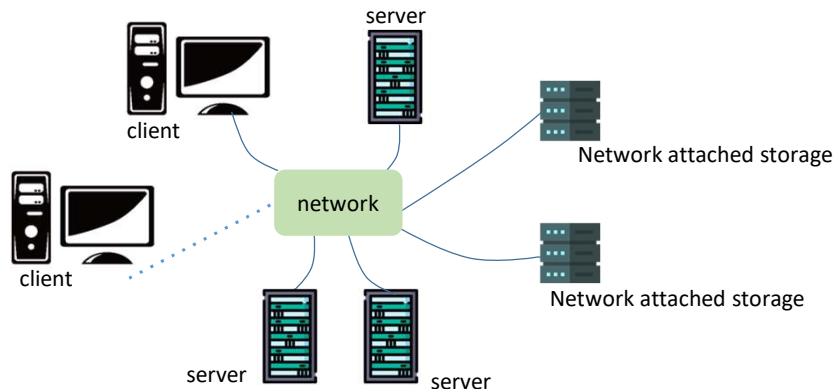
- Top security and huge capacity, higher speed and performance
- Large company

<https://www.youtube.com/watch?v=bpUzGZLO948>



## Enterprise Storage – NAS

**Network attached storage (NAS)** is a server placed on the network, its sole purpose is to provide storage for users, computers and devices connected to the network

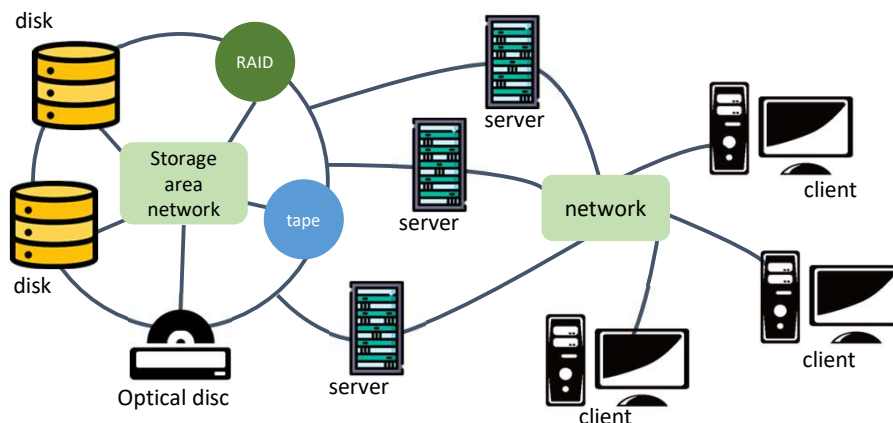


An example of how network attached storage connects on a network



## Enterprise Storage - SAN

A storage area network (SAN) is a high-speed network with the sole purpose of providing storage to other attached servers



Clip: <https://www.youtube.com/watch?v=3yZDDr0JKVc>



## The World Wide Web

The **World Wide Web (WWW)**, or web, consists of a worldwide collection of electronic documents (**webpages**)

A website is a collection of related webpages and related items

A **web server** is a computer that delivers requested webpages to your computer or mobile device

**HTML** (Hypertext Markup Language) is a set of symbols used by developers to specify the headings, paragraphs, images, links, and other content elements that contained in webpages

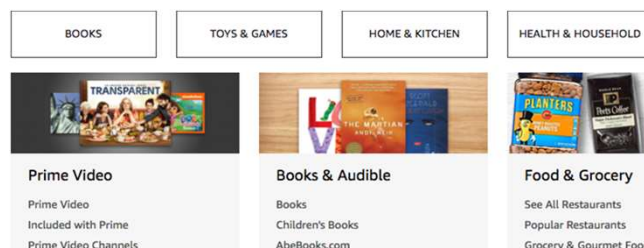


## Types of Websites - Search Engine

A web **search engine** is software that finds websites, webpages, images, videos, news, maps, and other information related to a specific topic

- Adaptive results

A **subject directory** classifies webpages in an organized set of categories, such as sports or shopping, and related subcategories

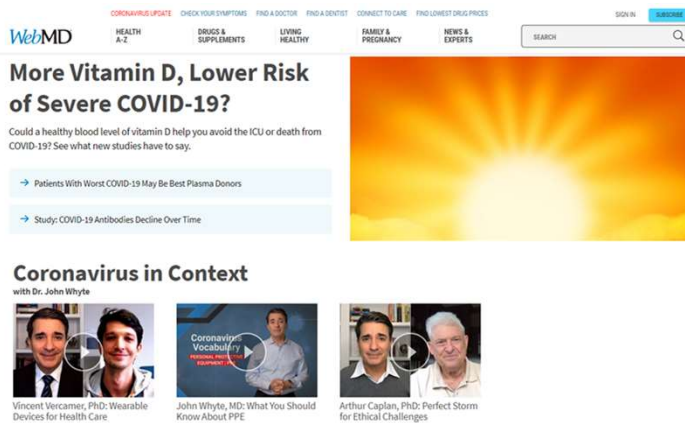




## Types of Websites - Informational and research

Informational and research websites contain factual info

- Library, encyclopedias, dictionaries, etc.



Google Scholar

Articles Case law



## Types of Websites – E-commerce

**Course activity-** compare the following E-commerce website

- Similarity, difference, uniqueness, characteristic, etc.

amazon



PChome ONLINE



ebay

Walmart Save money. Live better.

YAHOO! 奇摩 拍賣





## Types of Websites - Online social network



Photo credit: <http://MakeAWebsiteHub.com>



## Types of Websites - Wikis and Collaboration



**WIKIPEDIA**  
The Free Encyclopedia



**scistarter**  
Citizen Science Projects

Photo credit: <http://MakeAWebsiteHub.com>



## Other Internet Services

**FTP** (File Transfer Protocol) is an Internet standard that allows file upload and download to and from other computers on the Internet

- Some of the FTP sites have anonymous FTP
- Some FTP sites require an authorized account

Many operating systems include FTP capabilities

An **FTP server** is a computer that allows users to upload and/or download files using FTP